

1 62. A method of determining a movement characteristic of an object, the object having a  
2 movement path section that is substantially non-curvilinear, comprising the steps of:

3 a) aligning a plurality of electro-magnetic energy transmission paths to be non-parallel to the  
4 object's substantially non-curvilinear movement path section;

5 b) reflecting electro-magnetic energy from each of the plurality of transmission paths off the  
6 object for at least a portion of the substantially non-curvilinear movement path section;

7 c) receiving the electro-magnetic energy reflected off the object from each of the plurality of  
8 transmission paths; and

9 d) determining a movement characteristic of the object based on the reflected electro-  
10 magnetic energy received from each of the plurality of transmission paths and while the  
11 object was traveling in the at least a portion of the substantially non-curvilinear  
12 movement path section.

1 63. The method of determining a movement characteristic of an object of claim 62, wherein step  
2 d) includes determining one of the speed, direction, distance, and location of the object based  
3 on the reflected electro-magnetic energy.

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1 64. The method of determining a movement characteristic of an object of claim 63, wherein step  
2 d) includes:

- 3 i) determining parameters of a model of the non-curvilinear movement  
4 section of the object based on the reflected electro-magnetic energy from  
5 the plurality of transmission paths; and  
6 ii) determining a movement characteristic of the object based on the  
7 determined model parameters.

a<sup>4</sup>  
cont. 1 65. The method of determining a movement characteristic of an object of claim 62, wherein the  
2 movement characteristic to be determined is the object's spin rate, further comprising the step  
3 of applying an electro-magnetic contrasting mark to the object and step d) includes  
4 determining the object's spin rate based on the electro-magnetic energy received from the  
5 plurality of transmission paths while the object was traveling in the at least a portion of the  
6 substantially non-curvilinear movement path section.

1 66. The method of determining a movement characteristic of an object of claim 62, wherein the  
2 movement characteristic to be determined is the object's spin axis orientation, further  
3 comprising the step of applying an electro-magnetic contrasting mark to the object and step  
4 d) includes determining the object's spin axis orientation based on the electro-magnetic  
5 energy received from the plurality of transmission paths while the object was traveling in the  
6 at least a portion of the substantially non-curvilinear movement path section.

1 67. The method of determining a movement characteristic of an object of claim 62, wherein the  
2 object is a golf ball and the substantially non-curvilinear movement path section is located  
3 within several feet of the location of where the golf ball is struck.

1 68. The method of determining a movement characteristic of an object of claim 62, wherein the  
2 plurality of transmission paths includes at least three transmission paths.

1 69. The method of determining a movement characteristic of an object of claim 62, wherein the  
2 plurality of transmission paths consists of two transmission paths.

1 70. The method of determining a movement characteristic of an object of claim 62, wherein the  
2 plurality of transmission paths consists of three transmission paths.

1 71. A method of determining the spin rate of a moving object, comprising the steps of:  
2 a) applying an electro-magnetic contrasting mark to the object;  
3 b) reflecting electro-magnetic energy off the object from a plurality of transmission paths;  
4 c) receiving the electro-magnetic energy reflected off the object from the plurality of  
5 transmission paths; and  
6 d) determining the spin rate of the object based on the received electro-magnetic energy  
7 from the plurality of transmission paths.

1 72. The method of determining the spin rate of the object of claim 71, wherein step d) includes:

- 2 i) determining parameters of a model of the movement of the object based on  
3 the reflected electro-magnetic energy received from the plurality of  
4 transmission paths; and  
5 ii) determining the spin rate of the object based on the determined model  
6 parameters.

a<sup>4</sup> 1 73. The method of determining the spin rate of the object of claim 71, wherein the object is a golf  
2 ball.

cont. 1 74. The method of determining the spin rate of the object of claim 71, wherein the contrasting  
2 mark is not discernable at the visible light spectrum.

1 75. The method of determining the spin rate of the object of claim 71, wherein the contrasting  
2 mark is highly reflective of the electro-magnetic energy.

3  
4 76. The method of determining the spin rate of the object of claim 71, wherein step a) includes  
5 applying a plurality of electro-magnetic contrasting marks to the object.

6 77. A method of determining the spin axis orientation of a moving object, comprising the steps

7 of:

8 a) applying an electro-magnetic contrasting mark to the object;

9 b) reflecting electro-magnetic energy off the object from a plurality of transmission paths;

10 c) receiving the electro-magnetic energy reflected off the object from the plurality of  
11 transmission paths; and

12 d) determining the spin axis orientation of the object based on the received electro-magnetic  
13 energy from the plurality of transmission paths.

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cont. 1 78. The method of determining the spin axis orientation of the object of claim 77, wherein step d)

2 includes:

3 i) determining parameters of a model of the movement of the object based on  
4 the reflected electro-magnetic energy from the plurality of transmission  
5 paths; and

6 ii) determining the spin axis orientation of the object based on the determined  
7 model parameters.

1 79. The method of determining the spin axis orientation of the object of claim 77, wherein the

2 object is a golf ball.

1 80. The method of determining the spin axis orientation of the object of claim 79, wherein the

2 contrasting mark is not discernable at the visible light spectrum.

1 81. The method of determining the spin axis orientation of the object of claim 79, wherein the  
2 contrasting mark is highly reflective of the electro-magnetic energy.

3 82. The method of determining the spin axis orientation of the object of claim 79, wherein step a)  
4 includes applying a plurality of electro-magnetic contrasting marks to the object.

5 83. The method of determining the spin axis orientation of the object of claim 79, further  
6 comprising the step of aligning the plurality of electro-magnetic energy transmission paths to  
7 be non-parallel to each of the other paths of the plurality of electro-magnetic energy  
8 transmission paths.

9 84. The method of determining a movement characteristic of an object of claim 83, wherein the  
10 plurality of transmission paths includes at least three transmission paths.

1 85. The method of determining a movement characteristic of an object of claim 83, wherein the  
2 plurality of transmission paths consists of two transmission paths.

1 86. The method of determining a movement characteristic of an object of claim 83, wherein the  
2 plurality of transmission paths consists of three transmission paths.

1 87. An apparatus for determining a movement characteristic, comprising:

- 2 a) a moving object, the object having a movement path section that is substantially non-
- 3 curvilinear;
- 4 b) a plurality of sensors, each sensor having an electro-magnetic energy transmission path
- 5 that is aligned to be non-parallel to the object's substantially non-curvilinear movement
- 6 path section, each sensor reflecting electro-magnetic energy along its transmission path
- 7 off the object for at least a portion of the substantially non-curvilinear movement path
- 8 section, and each sensor receiving electro-magnetic energy reflected off the object; and
- 9 c) means for determining a movement characteristic of the object based on the electro-
- 10 magnetic energy received at each of the plurality of sensors while the object was traveling
- 11 in the at least a portion of the substantially non-curvilinear movement path section.

1 88. The apparatus for determining a movement characteristic of claim 87, wherein the movement

2 characteristic is one of the speed, direction, distance, and location of the object based on the

3 reflected electro-magnetic energy.

1 89. The apparatus for determining a movement characteristic of claim 88, wherein means for

2 determining a movement characteristic includes:

- 3 i) means for determining parameters of a model of the non-curvilinear
- 4 movement section of the object based on the electro-magnetic energy
- 5 received from the plurality of sensors; and
- 6 ii) means for determining the movement characteristic of the object based on
- 7 the determined model parameters.

1 90. The apparatus for determining a movement characteristic of claim 87, wherein the movement  
2 characteristic to be determined is the object's spin rate, the object includes an electro-  
3 magnetic contrasting mark and the means for determining the movement characteristic  
4 includes means for determining the object's spin rate based on the electro-magnetic energy  
5 received from the plurality of sensors while the object was traveling in the at least a portion  
6 of the substantially non-curvilinear movement path section.

1 91. The apparatus for determining a movement characteristic of claim 87, wherein the movement  
2 characteristic to be determined is the object's spin axis orientation, the object includes an  
3 electro-magnetic contrasting mark and the means for determining the movement  
4 characteristic includes determining the object's spin axis orientation based on the electro-  
5 magnetic energy received from the plurality of sensors while the object was traveling in the at  
6 least a portion of the substantially non-curvilinear movement path section.

1 92. The apparatus for determining a movement characteristic of claim 87, wherein the object is a  
2 golf ball and the substantially non-curvilinear movement path section is located within  
3 several feet of the location of where the golf ball is struck.

1 93. The apparatus for determining a movement characteristic of claim 87, wherein the plurality of  
2 sensor includes at least three sensors.

1 94. The apparatus for determining a movement characteristic of claim 87, wherein the plurality of  
2 sensors consists of two sensors.



1 95. The apparatus for determining a movement characteristic of claim 87, wherein the plurality of  
2 sensors consists of three sensors.

1 96. An apparatus for determining a spin rate, comprising:

- 2 a) a moving object having an electro-magnetic contrasting mark;  
3 b) a plurality of sensors each that reflects electro-magnetic energy off the object and receives  
4 electro-magnetic energy reflected off the object; and  
5 c) means for determining the spin rate of the object based on the electro-magnetic energy  
6 received by the plurality of sensors.

1 97. The apparatus for determining a spin rate of claim 96, wherein the means for determining the  
2 spin rate includes:

- 3 i) means for determining parameters of a model of the movement of the  
4 object based on the electro-magnetic energy received by the plurality of  
5 sensors; and  
6 ii) means for determining the spin rate of the object based on the determined  
7 model parameters.

1 98. The apparatus for determining a spin rate of claim 96, wherein the object is a golf ball.

1 99. The apparatus for determining a spin rate of claim 98, wherein the contrasting mark is not  
2 discernable at the visible light spectrum.

1 100. The apparatus for determining a spin rate of claim 98, wherein the contrasting  
2 mark is highly reflective of the electro-magnetic energy.

3 101. The apparatus for determining a spin rate of claim 98, wherein the object includes  
4 a plurality of electro-magnetic contrasting marks.

a 4 5 102. An apparatus for determining a spin axis orientation, comprising:

- 6 a) a moving object having an electro-magnetic contrasting mark;  
7 b) a plurality of sensors, each sensor reflecting electro-magnetic energy off the object and  
8 receiving electro-magnetic energy reflected off the object; and  
9 c) means for determining the spin axis orientation of the object based on the electro-  
10 magnetic energy received at each of the plurality of sensors.

1 103. The apparatus for determining the spin axis orientation of claim 102, wherein  
2 means for determining the spin axis orientation includes:

- 3 i) means for determining parameters of a model of the movement of the  
4 object based on the electro-magnetic energy received at the plurality of  
5 sensors; and  
6 ii) means for determining the spin axis orientation of the object based on the  
7 determined model parameters.

1 104. The apparatus for determining the spin axis orientation of claim 102, wherein the  
2 object is a golf ball.

1 105. The apparatus for determining the spin axis orientation of claim 104, wherein the  
2 contrasting mark is not discernable at the visible light spectrum.

1 106. The apparatus for determining a spin axis orientation of claim 104, wherein the  
2 contrasting mark is highly reflective of the electro-magnetic energy.

3 107. The apparatus for determining a spin axis orientation of claim 104, wherein the  
4 object has a plurality of electro-magnetic contrasting marks.

5 108. The apparatus for determining the spin axis orientation of claim 104, wherein  
6 each sensor of the plurality of sensors has an electro-magnetic energy transmission path that  
7 is aligned to be non-parallel to each of the other plurality of sensors' electro-magnetic energy  
8 transmission path.

9 109. The apparatus for determining the spin axis orientation of claim 108, wherein the  
10 plurality of sensors includes at least three sensors.

1 110. The apparatus for determining the spin axis orientation of claim 108, wherein the  
2 plurality of sensors consists of two sensors.

1 111. The apparatus for determining the spin axis orientation of claim 108, wherein the  
2 plurality of sensors consists of three sensors.

1 112. A ball adapted for determination a movement characteristic, comprising:  
2 an area having an electro-magnetic contrast different from the ball  
3 remainder, the area configured to enable the determination of the ball's  
4 movement characteristic based on electro-magnetic energy reflected off the area  
5 from a plurality of transmission paths.  
6

1 113. The ball adapted for determination a movement characteristic of claim 112,  
2 wherein the movement characteristic is one of the speed, direction, distance, and location of  
3 the object based on the reflected electro-magnetic energy.

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cont. 1 114. The ball adapted for determination a movement characteristic of claim 112,  
2 wherein the area is symmetrical.

1 115. The ball adapted for determination a movement characteristic of claim 112, the  
2 ball including a plurality of areas where the areas are non-overlapping.

1 116. The ball adapted for determination a movement characteristic of claim 115,  
2 wherein the plurality of areas are symmetrical.

1 117. The ball adapted for determination a movement characteristic of claim 115,  
2 wherein the plurality of areas are circular.

1 118. The ball adapted for determination a movement characteristic of claim 112,  
2 wherein the movement characteristic to be determined is the ball's spin rate.

1 119. The ball adapted for determination a movement characteristic of claim 112,  
2 wherein the movement characteristic to be determined is the ball's spin axis orientation.

1 120. The ball adapted for determination a movement characteristic of claim 119,  
2 wherein the ball is a golf ball.

a4 1 121. The ball adapted for determination a movement characteristic of claim 119,  
2 wherein the plurality of sensor includes at least three sensors. B

cm4 1 122. The ball adapted for determination a movement characteristic of claim 112,  
2 wherein the area is configured to enable the determination of the ball's movement  
3 characteristic based on electro-magnetic energy reflected off the area from at least two  
4 transmission paths.

1 123. The ball adapted for determination a movement characteristic of claim 112,  
2 wherein the area is configured to enable the determination of the ball's movement  
3 characteristic based on electro-magnetic energy reflected off the area from at least two  
4 transmission paths.